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WA-28

PACIFIC WOODTREATING CORPORATION
CLASS II INSPECTION

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ABSTRACT

A stormwater runoff study was conducted at Pacific Woodtreating Corporation (PWT) in Ridgefield. The purpose of the study was to gather information concerning possible contamination of rainfall runoff from the PWT site. Stormwater runoff was sampled on three occasions. Sediments from Lake River and two on-site catch basins were analyzed. The study revealed pentachlorophenol (PCP) and polynuclear aromatic hydrocarbons (PNA) are present in PWT surface runoff, on-site sediment catch basins, and some near-field sediments. Runoff concentrations of PCP may be the main cause of the high toxicity measured by three bioassays, although PNA's and metals may have contributed. The on-site catch basin sediments were highly contaminated with PNA's, while the sediment sample from Lake River at Outfall #3 contained more modest amounts. Sediment bioassay toxicity appeared to be closely linked to sediment PNA concentrations. Catch basin sediments exceeded Washington's designation level for PNA's as a dangerous waste, and had high concentrations of several metals. Several recommendations were made concerning further definition of contaminated streams, management practices, and bioassay and chemical monitoring.

INTRODUCTION

A stormwater runoff study was conducted at Pacific Woodtreating Corporation (PWT) in Ridgefield. The survey was requested by Jon Neel and Gary Bailey of Ecology's Southwest Regional Office. Don Reif of Environmental Investigations'(EI) Compliance Monitoring Section headed the inspection. Field assistance was provided by Marc Heffner, John Bernhardt, and Carolyn Abshire of EI, respectively, during the three field sampling phases. Bryant Adams and Tom Newman of PWT also contributed a considerable amount of time and assistance to the project.

Objectives of the study were to:

1. Identify stormwater runoff contaminants.

2. Estimate runoff contaminant mass loadings.

3. Consider potential for treatment of runoff contaminants.

4. Make recommendations for decreasing contaminant runoff.

5. Assess runoff toxicity by conducting a series of bioassays.

6. Identify contaminants in sediment samples near storm drain outfalls, and run sediment bioassays.

LOCATION AND DESCRIPTION

PWT is located in Clark County about fifteen miles north of Vancouver (Figure 1). It is on the east bank of Lake River, a sluggish stream connecting Vancouver Lake with the Columbia River. Lake River is the natural outlet for Vancouver Lake, and its flow rate is quite low for much of the year. In 1983, an inlet channel from the Columbia River to Vancouver Lake was constructed, adding a flow of approximately 5 cubic feet per second (3.2 MGD) to Lake River. Flow of Lake River is not measured (R. Williams, USGS, Tacoma, personal communication).

From the 1920s until 1964, the PWT site was occupied by a variety of business concerns. Among these were cedar, shake, and fir mills; marinas; tank storage farms for oil companies; a veneer plant; boat building; a floating machine shop; log rafting; potato warehouse; and general trash disposal in Lake River near PWT (Adams, 1988).

PWT began operation in 1964 as a specialty wood product manufacturer. Their products include treated lumber (power poles and pilings), tent poles and pegs for the U.S. Army, and guitar backs. Lumber is treated with pentachlorophenol (PCP), creosote, or CCA (copper, chrome, arsenic).

A large part of PWT's business is the pressure treating of lumber and poles (especially telephone poles) with creosote and/or PCP. A series of oil/water separators treat the wastewaters. The oil portion is returned to the process. The remaining wastewater is concentrated by a dissolved air flotation thickener. This thickened portion is recycled to the process, and subnatent is evaporated in a cooling tower. The system is therefore classified as "zero discharge" of process pollutants.

PWT's NPDES (National Pollutant Discharge Elimination System) permit has expired and is awaiting renewal. When reissued, the permit will address discharge of stormwater runoff as well as process wastewater. Ground water monitoring and soil contamination are also issues to be checked in the future (M. Templeton, Ecology, personal communication).

METHODS

Stormwater runoff from the PWT plant site was sampled on three separate occasions. Table 1 lists the sampling schedule, and sampling locations are shown on Figure 2.

Phase 1 was conducted October 30, 1986, during the "first flush" major rain event of the fall. Phase 2 samples were collected by PWT personnel on March 3, 1987, during a period of heavy rain. Phase 3 was conducted on November 24, 1987, after a few significant rain storms. Phases 1 and 3 included joint sampling with splits between PWT and Ecology. A summary of analytical methods and laboratories used are listed in Table 2.

Runoff samples consisted of two grab composites, one morning and one afternoon. Sample containers were filled half full in the morning and placed on ice. The other half was added in the afternoon, again placed on ice, and delivered to the lab the next morning. The exception

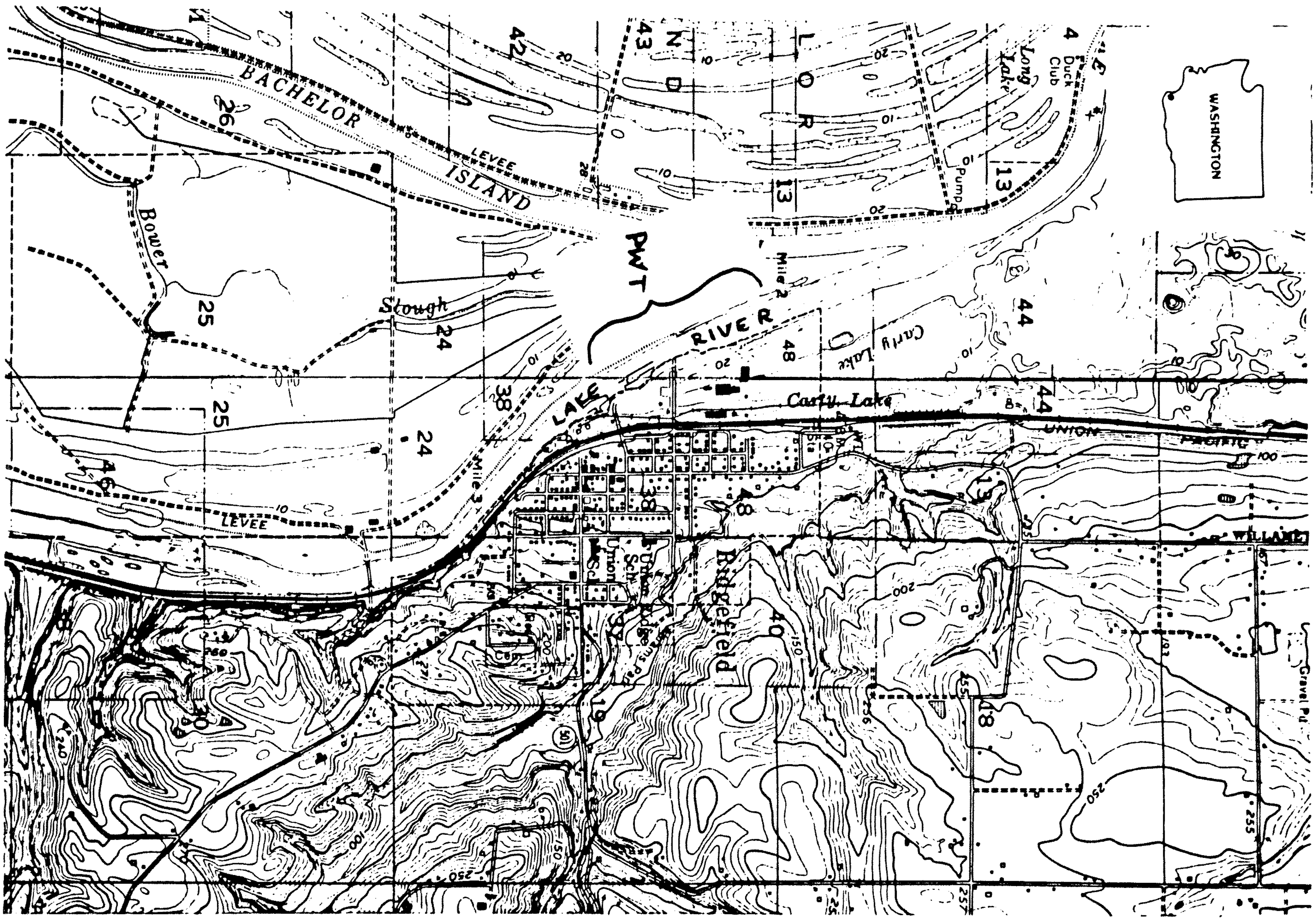

Figure 1. Site Location - Pacific Woodtreating Corporation Class II Inspection, 1986-87.

Table 1. Sampling Schedule-Pacific Woodtreating Corporation Class II Inspection: 1986-1987.

				Field Analysis				Laboratory Analysis																	
																			Bioassays						
Sample Phase #	Analysis by	Site #	Date	Flow	Temperature °	pH	Conductivity	Conductivity	TSS	COD	Oil & Grease	BNA	VOA	Pest./PCB	PP Metals	Cu, Cr, As	PCP	Tot. Arom.	Trout	Ceriodaphnia	Selenastrum	D. magna	% Solids	TOC	Grain Size
1.	ECO	1	10/30/86	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X				
		1a	10/30/86	X				X	X	X	X	X	X												
		2	10/30/86	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X				
		3	10/30/86	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X				
		3a	10/30/86	X				X	X	X	X	X	X	X											
		3b	10/30/86	X					X	X	X	X													
		2a	10/30/86					X				X	X	X											
	PWT	1	10/30/86							X	X	X				X									
		2	10/30/86							X	X	X				X									
		3	10/30/86							X	X	X				X									
Sediment		Control	12/09/86									X	X	X	X							X	X	X	X
	ECO	1	12/09/86									X	X	X	X							X	X	X	X
		2	12/09/86									X	X	X	X							X	X	X	X
		3	12/09/86									X	X	X	X							X	X	X	X
		D1	12/09/86									X	X	X	X							X	X	X	X
		D3a	12/09/86									X	X	X	X							X	X	X	X
2.	PWT	1	03/03/87	X					X	X	X	X				X	X								
		1a	03/03/87	X					X	X	X	X				X	X								
		2	03/03/87	X					X	X	X	X				X	X								
		2a	03/03/87	X					X	X	X	X				X	X								
		3	03/03/87	X					X	X	X	X				X	X								
		3a	03/03/87	X					X	X	X	X				X	X								
		3d	03/03/87	X					X	X	X	X				X	X								
		3e	03/03/87	X					X	X	X	X				X	X								
3.	ECO	1	11/24/87	X	X	X	X			X							X	X							
		2	11/24/87	X	X	X	X			X							X	X							
		2b	11/24/87	X	X	X	X			X								X							
		3	11/24/87	X	X	X	X			X							X	X							
		3c	11/24/87	X	X	X	X			X								X							
		3d	11/24/87	X	X	X	X			X								X							
		3e	11/24/87	X	X	X	X			X								X							
		4	11/24/87	X	X	X	X		X	X	X	X				X		X							
		4a	11/24/87	X	X	X	X			X								X							
	PWT	1	11/24/87						X	X						X	X	X							
		2	11/24/87						X	X	X	X				X		X							
		2b	11/24/87						X	X							X								
		3	11/24/87						X	X	X	X				X		X							
		3c	11/24/87						X	X							X	X							
		3d	11/24/87						X	X							X	X							
		3e	11/24/87						X	X							X	X							
		4	11/24/87						X	X	X	X				X		X							
		4a	11/24/87						X	X							X	X							

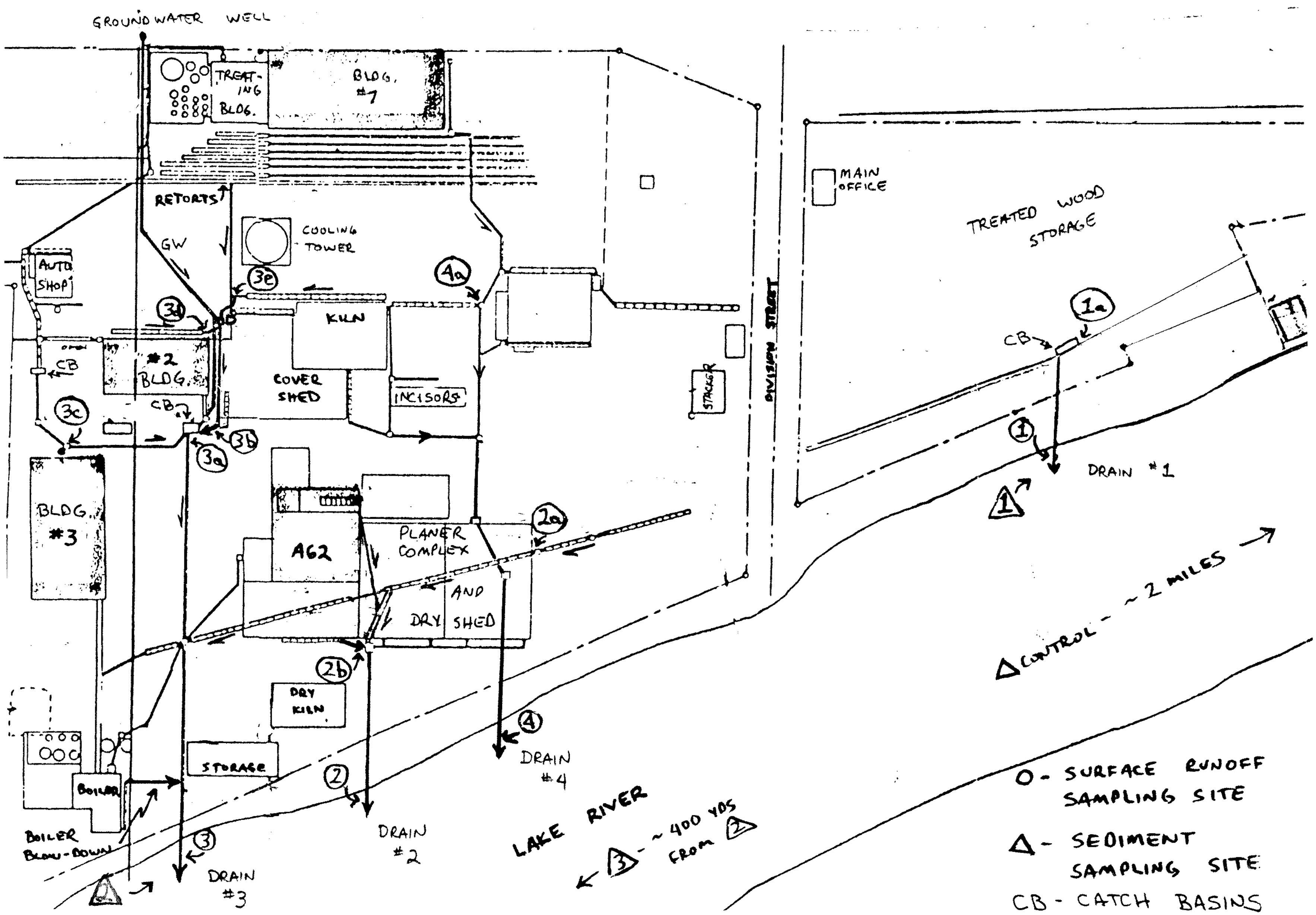

Figure 2. Plant diagram with stormwater collection system and sampling locations: Pacific Woodtreating Corporation Class II Inspection, 1986-1987.

was for VOA's; each vial was filled completely in the morning. Flow was recorded at each location at each sampling, then averaged. Flow measurement consisted of bucket and stop watch at the outfalls, and either bucket and stop watch or Marsh-McBirney flowmeter at the upstream locations.

Three bioassay organisms were used to test runoff toxicity on the first sample set. The bioassays and references are listed in Table 2.

Sediment samples were collected on December 9, 1986. These locations are noted on Figure 2. Four sites were sampled in Lake River; one each near outfalls #1 and #3, plus one site four hundred yards downstream of outfall #3, and a control approximately two miles upstream. Sediment was also analyzed from catch basins in runoff collection system #1 and site #3a. Sampling procedures conformed to Puget Sound Protocols (Tetra Tech, 1986).

Some problems were encountered with PWT's sampling protocols. In Phase 1, PWT's samples were not submitted for analysis until one month after sampling. Thus, holding times were exceeded for base/neutral acids (BNA's). An evaluation of the data packages for both contract labs (ARI for Ecology samples; Coffey for PWT) concluded that more confidence could be placed on the ARI data (Farlow, 1987). These data are therefore listed for Phase 1 results. Contract labs used by PWT should deliver acceptable results if proper containers and cleaning protocols have been followed, holding times are not exceeded, and complete QA/QC data packages (method blanks, surrogate spikes, and replicates) are submitted and evaluated. It is highly desirable that the lab be certified with the EPA Contract Lab Program (CLP) and that the CLP reporting format be requested and followed.

Questions about collection system location and direction of flow prompted a visit to the site on May 21, 1987. Several inaccuracies were found in PWT's existing flow diagram. Most notable was the discovery of a fourth outfall, hence designated as Outfall #4. This outfall was included in Phase 3 sampling.

RESULTS

General Conditions

A detailed, accurate diagram of the storm drain, surface runoff, and roof drain collection system at PWT is lacking. The present system has been modified over the years, including a major replacement at one time. In some places the present system lies beside, over, or under the older system. Further complicating identification is the fact that most of the system is below grade and occasionally under buildings, including junctions. Determining direction of flow, where lines meet, and generally "what goes where?" are often difficult questions to answer. A thorough understanding of this system is necessary before decisions can be made regarding separation of uncontaminated from contaminated flows, isolating areas of heaviest contaminant runoff, etc.

Housekeeping could be improved, in general. Treated wood was observed being stored in the north storage area that is designated for untreated wood. Also, better runoff control is needed.

Table 2. Analytical Methods for Pacific Woodtreating Corporation Class II Inspection: 1986-1987.

Sampling Period	Analysis	Sampler	Method	Number	Method Reference	Laboratory
1	Conductivity	Ecology	Beckman RC20 Meter	205	APHA (1985)	Ecology
	Total Suspended Solids*	Ecology	Filter	205C	APHA (1985)	Ecology
	Chemical Oxygen Demand*	Ecology	Reflux Digestion	410.1	EPA	Ecology
	Oil and Grease*	Ecology	Gravimetric	413.1	EPA	Ecology
	Acid/Base Neutrals*	Ecology	GC/MS	625	EPA	Analytical Resources, Inc.-Seattle
	Volatile Organic Acids	Ecology	GC/MS	624	EPA	Analytical Resources, Inc.
	Pesticides/PCBs	Ecology	GC/ECD	608	EPA	Analytical Resources, Inc.
	Priority Pollutant Metals	Ecology	AA	CLP #785	EPA	Ecology
	Rainbow Trout	Ecology	96-hour	--	DOE 80-12	Ecology
	Ceriodaphnia	Ecology	7-day Static Renewal	--	EPA 1985	EPA - ERL, Duluth, Minnesota
	Selenastrum	Ecology	96-hour	--	EPA 1985	E.V.S. Consultants, Vancouver, B.C.
	Chemical Oxygen Demand+	PWT	Reflux Digestion	410.1	EPA	Coffee, Portland, Oregon
	Oil and Grease	PWT	Gravimetric	413.1	EPA	Coffee, Portland, Oregon
	Acid/Base Neutral+	PWT	GC/MS	625	EPA	Coffee, Portland, Oregon
	Copper, Chromium, Arsenic+	PWT	ICP/HCL + HNO_3	200.7	EPA	Coffee, Portland, Oregon
Sediment						
	Base/Neutral Acids	Ecology	GC/MS	625	EPA	Analytical Resources, Inc.
	Volatile Organic Acids	Ecology	GC/MS	624	EPA	Analytical Resources, Inc.
	Pesticides/PCBs	Ecology	GC/ECD	608	EPA	Analytical Resources, Inc.
	Priority Pollutant Metals	Ecology	AA	CLP #785	EPA	Ecology
	Percent Solids	Ecology	Dry @ 105°C	209F	APHA (1985)	Ecology
	Total Organic Carbon	Ecology	Combustion/CO_2 Measure	--	In-house	Laucks Testing Labs.
	Grain Size	Ecology	Sieve and Pipet	--	Holme & McIntyre(1971)	Parametrix, Inc.
	Daphnia Magna	Ecology	48-hour Static	--	Nebeker(1984)	EPA-ERL, Corvallis, Oregon
2	Total Suspended Solids	PWT	Filter	205C	APHA (1983)	PWT
	Chemical Oxygen Demand	PWT	Reflux Digestion	410.1	EPA	Coffee, Portland, Oregon
	Oil and Grease	PWT	Gravimetric	413.1	EPA	Coffee, Portland, Oregon
	Pentachlorophenol	PWT	GC/FID	8040	EPA	Coffee, Portland, Oregon
	Copper, Chromium, Arsenic	PWT	ICP/HCL + HNO_3	200.7	EPA	Coffee, Portland, Oregon
	Acid/Base Neutrals	PWT	GC/FID	610	EPA	Coffee, Portland, Oregon
3	Pentachlorophenol	Ecology	GC/ECD	608	EPA	Ecology
	Total Aromatics	Ecology	UV Absorbance	--	In-house	Ecology
	Chemcial Oxygen Demand	PWT	Closed Reflux/Colormetric	508C	APHA (1985)	PWT
	Oil and Grease	PWT	Gravimetric	413.1	EPA	PWT
	Copper, Chromium	PWT	ICP/HCL	200.7	EPA	Columbia Analytical Services, Inc.
	Arsenic	PWT	AA/HNO_3	206.3	EPA	Columbia Analytical Services, Inc.
	Total Aromatics	PWT	UV Absorbance	--	In-house	Columbia Analytical Services, Inc.

+ Sample had exceeded recommended holding time when analyzed.
* Methods and lab are the same for the third sampling period.

Some rainfall runoff escapes directly to the river at various points in the log storage areas, both north and south, depending on rainfall intensity and duration. Sediment catch basins need to be cleaned periodically. In some cases, the basins were probably ineffective because they were filled with captured sediment.

Runoff Characteristics

Outfall results for the three sampling periods are shown in Table 3. Daily runoff totals are listed in Table 4 and comparisons in Table 5.

Site runoff ranged from 0.087 MGD (0.15 inch of rain for Phase 3) to 0.92 MGD (1.0 inch of rain for Phase 2). Daily runoff totals from all outfalls to Lake River were: suspended solids, 830 to 15,600 pounds; COD, 266 to 531 pounds; PCP, 0.16 to 3.7 pounds; PNA's, 0.16 to 6.0 pounds; and oil and grease, 6.6 to 42 pounds.

No single outfall had the highest total loading to Lake River for all three sample sets. Outfall #3 was highest in all categories for the first sampling period, and for PCP in the third period. Outfall #2 contributed the most TSS and COD for the last two sampling periods. Outfall #1 was highest in PNA's for the second and third periods and PCP for the second period.

It should be noted that rainfall intensity, and therefore runoff, was variable during the daily sampling process. This was especially true during Phase 3 when runoff collection was possible only during the intermittent showers. This factor may have affected comparison of concentrations and estimated daily totals for Phase 3. In the future, this effect might be minimized by sampling in a downstream direction, one collection system at a time.

Collection Systems Findings and Recommendations

Upstream sites on each collection system were sampled to try to locate areas of heaviest contaminant runoff. Each collection system is addressed separately below. Refer to Table 6 for data discussion. Complete BNA results are listed in Appendix I.

Outfall #1 drains the main treated log storage area. Runoff collects at one point near the bank of Lake River due to natural slope and some trenching and berming. An in-ground catch basin at this location is supposed to remove oil and grease and sediment before final discharge to Lake River. However, it may be doing neither. Oil and grease and TSS increased between the inlet (#1a) and outlet (#1) in Phases 1 and 2. PNA's, PCP, COD, and metals appeared to decrease from inlet to outlet. Outfall #1 had the lowest runoff flow but the highest concentrations during all three samplings, yielding the highest total loadings for several parameters.

Specific recommendations for system #1 include sediment removal from the catch basin. Higher levels of contaminants in the basin's effluent than influent may be due to washout of the captured sediment. Also, longer cooling time on the drip pad may reduce carry-over to this area.

Table 3. Sampling Results - Pacific Woodtreating Corporation Class II Inspection: 1986-1987

				Field Analysis				Laboratory Analysis								
												Total Metals (ug/L)				
Sample Phase #	Site #	Date	Time	Flow, gpm	Temp. °	pH	Cond.	Cond., mg/L	TSS, mg/L	COD, mg/L	O & G, mg/L	Copper	Chromium	Arsenic	PNA's, mg/L	PCP, mg/L
1	1	10/30/86	1005	3.8	11.7	7.0	455	495	220	370	6	421	134	249	.256	.107
		10/30/86	1300	37	11.9	7.3	525				9					
	2	10/30/86	1105	103	12.5	7.1	200	280	500	240	7	312	235	224	.025	.022
		10/30/86	1345	20	12.5	6.9	220				10					
	3	10/30/86	1050	147	13.9	7.1	250	292	220	140	3	127	74	57	.085	.068
		10/30/86	1330	166	13.2	7.1	290				6					
	1a+	10/30/86	1310	37	--	--	--	639	140	480	7	--	--	--	.437	.167
	2a+	10/30/86	1115	42	--	--	--	268	1700	540	11	--	--	--	.070	.063
	3a+	10/30/86	1214	150	--	--	--	306	330	150	7	--	--	--	.085	.075
	3b+	10/30/86	1216	--	--	--	--	--	--	--	--	--	--	--	.092	.128
2	1	03/03/87	1000	144	--	--	--	--	786	<10	10.1	164	112	<200	2.58	.970
		03/03/87	1500	198	--	--	--									
	2	03/03/87	1040	162	--	--	--	--	3950	240	4.6	691	754	467	0.036	.190
		03/03/87	1530	210	--	--	--									
	3	03/03/87	1130	228	--	--	--	--	1520	42	3.2	193	136	200	0.20	.21
		03/03/87	1600	340	--	--	--									
	1a	03/03/87	1015	139	--	--	--	--	596	42	3.5	211	155	<200	1.16	1.20
		03/03/87	1515	198	--	--	--									
	2a	03/03/87	1100	103	--	--	--	--	3350	106	6.9	384	419	199	0.098	.050
		03/03/87	1545	178	--	--	--									
	3a	03/03/87	1145	183	--	--	--	--	1235	42	7.0	177	145	<200	0.056	.300
		03/03/87	1630	264	--	--	--									
	3d	03/03/87	0930	32	--	--	--	--	875	176	14.0	159	122	<200	0.122	.240
		03/03/87	1400	34	--	--	--									
	3e	03/03/87	0945	12.7	--	--	--	--	34	53	1.8	65	25	<200	0.021	.850
		03/03/87	1445	18.7	--	--	--									
3	1	11/24/87	1140	5.1	9.2	7.5	560	--	1290	500	--	560	260	310	2.5	.750
		11/24/87	1508	3.1	9.2	7.4	560	--	--	--	--					
	2	11/24/87	1120	3.2	10.2	8.1	225	--	2380	730	14.6	480	510	330	.052	.060
		11/24/87	1500	28.3	8.6	8.1	160	--								
	3	11/24/87	1100	28.4	21.8	9.6	418	--	640	170	7.7	110	70	140	.032	.230
		11/24/87	1440	32.9	15.8	7.9	358	--								
	4	11/24/87	1200	6.7	10.6	7.4	140	--	660	330	8.2	237	177	126	.089	.190
		11/24/87	1520	13.7	9.2	7.6	121	--	--	--	12.2					
	2b	11/24/87	1315	1.4	9.3	7.8	372	--	34900	7400	--	--	--	--	--	.020
		11/24/87	1608	1.4	8.6	7.6	352	--	--							
	3c	11/24/87	1305	1.4	10.3	7.3	280	--	6270	1500	--	--	--	--	--	.35
		11/24/87	1600	5.5	9.4	7.3	362	--								
	3d	11/24/87	1235	4.7	10.8	7.6	178	--	1360	1100	--	--	--	--	--	.056
		11/24/87	1538	3.1	9.8	7.5	166	--								
	3e	11/24/87	1245	4.9	10.2	7.5	180	--	510	360	--	--	--	--	--	.14
		11/24/87	1545	1.4	9.9	7.6	143	--								
	4a	11/24/87	1225	3.0	9.6	7.4	128	--	740	460	--	--	--	--	--	.33
		11/24/87	1530	1.7	9.0	7.6	95	--								

+ - in Phase 1 sampling, these samples were a single grab. All others consisted of two-grab composites.

Table 4. Daily site runoff totals for selected parameters-Pacific Woodtreating Corporation Class II Inspection: 1986-1987

Date	Rainfall (inches)	Flow (mgd)	lbs/day TSS	COD	PCP	PNA	Oil and Grease
10/30/86	0.18	0.343	834	531	0.17	0.24	17
03/03/87	1.0	0.923	15,600	689	3.7	6.0	42
11/24/87*	0.15	0.087	831	266	0.16	0.16	6.6+

* includes Outfall #4
+ Does not include oil and grease from Outfall #1

Table 5. Runoff load comparison between outfalls-Pacific Woodtreating Corporation Class II Inspection: 1986-1987. Units are pounds per day.

Sampling Date	Rain-fall (in.)	Flow mgd	TSS #1	TSS #2	TSS #3	TSS #4	COD #1	COD #2	COD #3	COD #4	PCP #1	PCP #2	PCP #3	PCP #4	PNA #1	PNA #2	PNA #3	PNA #4	Oil and Grease #1	Oil and Grease #2	Oil and Grease #3	Oil and Grease #4
10/30/86	0.18		54	370	410	--	91	177	263	--	.026	.016	.13	--	.063	.019	.16	--	1.8	6.3	8.5	--
03/03/87	1.0		1610	8830	5180	--	<21	536	143	--	2.5	.43	.72	--	5.3	.069	.68	--	21	10	11	--
11/24/87	0.15		64	451	235	81	25	138	63	40	.037	.011	.085	.023	.12	.010	.012	.014	--	2.8	2.8	1.0

Outfall #2 drains Building A62 (untreated wood storage) and areas east and north. Because of its distance from the retorts and treated wood storage, this outfall was presumed to be the least contaminated, and this seemed to be the case. Outfall #2 had the lowest loading of PCP and PNA's for all three sample sets. It did, however, have the highest TSS and COD loadings during Phases 2 and 3.

Site #2a, at the north side of building A62, was sampled during Phases 1 and 2. The majority of system #2's flow seemed accounted for at this site, but the percent of contaminant load varied greatly between the two sampling periods. Site #2b was then selected for Phase 3 sampling because of questions regarding the confusing intersection of piping on the west side of building A62. This site sampled flow running south along the grated ground drain into the main junction box. Flow was very small and muddy. It contributed a high percent of TSS and COD to outfall #2, but very little PCP. The majority of contamination to outfall #2 probably originates to the north and east of building A62.

Outfall #2 has the lowest priority for further treatment because it consistently had the lowest PNA and PCP loads. Future bioassay and chemical tests should be run to confirm this information.

Outfall #3 is the most complicated collection system at PWT. This system collects runoff from the retort, drip pad, and evaporation tower areas, and also from the tank farm and shop and vehicle washing areas. These two lines meet at the "concrete pond," along with a ground water line (90 gpm, now stopped since city drinking water wells went off-line) from a well uphill from the tank farm (Figure 1). It then flows directly to Lake River while picking up additional surface- and roof runoff and boiler blowdown water at a second concrete junction box.

Site numbers 3d and 3e sampled runoff directly downhill from the retorts, drip pad, and cooling tower areas. It is believed that these two streams flow to the wet well for the Marlow pump, then are pumped to the concrete pond. In Phases 1 and 2, the majority of the contamination in system 3 was found in the concrete pond effluent (#3a). In Phase 3, sample #3c was also collected ahead of the concrete pond from the stream draining the auto shop area. Sites 3c, 3d, and 3e should therefore contain the majority of all contamination in system #3. The results, however, did not seem to confirm this assumption. In the Phase 3 samples, these sites combined for only 27 percent of the total PCP, and most of the PCP was from sample #3c. The apparent anomaly of Phase 3 sampling results could be due to the spotty rainfall, or perhaps other contaminant sources present.

Further testing of sites 3a, 3c, 3d, and 3e are recommended to substantiate the source(s) of high contamination to the concrete pond. Also, sediments should be removed from the catch basin and both concrete ponds if the deposits are deep enough to be washing out. Chemical characterization of the boiler blowdown water is suggested. Separation of presumably "clean" roof runoff drains should be considered.

Table 6. Daily runoff totals with percent contribution to outfall total loading*-Pacific Woodtreating Corporation Class II Inspection: 1986-1987.

					lbs./day															
Sample Site #	Sampling Period	Daily Rainfall	Flow (gal/day)	%	TSS	%	COD	%	PCP	%	PNA's	%	Cu	%	Cr	%	As	%	O & G	%
1	1	0.18"	29,400		54		91		0.026		0.063		0.10		0.03		0.06		1.8	
1a	1		29,400	100	34	63	118	130	0.041	158	0.110	175	--	--	--	--	--	--	1.7	94
1	2	1.0"	246,000		1,610		<21		2.5		5.3		0.34		0.23		<0.41		21	
1a	2		246,000	100	1,220	76	86	<410	2.5	0	2.4	45	0.43	127	0.32	140	<0.41	0	7.2	34
1	3	0.15"	5,900		63.5		25		0.037		0.12		0.028		0.013		0.015		--	
2	1	0.18"	88,600		370		177		0.016		0.019		0.23		0.17		0.17		6.3	
2a	1	0.18"	60,500	68	860	232	272	154	0.032	200	0.036	189	--	--	--	--	--	--	5.6	89
2	2	1.0"	268,000		8,830		536		0.43		0.069		1.5		1.7		1.04		10.3	
2a	2	1.0"	202,000	75	5,640	64	179	33	0.084	20	0.16	232	0.65	43	0.71	42	<0.34	<33	11.6	113
2	3	0.15"	22,700		451		138		0.011		0.010		0.091		0.097		0.062		2.8	
2b	3	0.15"	2,020	9	588	131	125	91	0.00034	3.1	--	--	--	--	--	--	--	--	--	--
3	1	0.18"	225,400		410		263		0.13		0.16		0.24		0.14		0.11		8.5	
3a	1	0.18"	216,000	96	590	144	270	103	0.14	108	0.15	94	--	--	--	--	--	--	12.6	148
3	2	1.0"	409,000		5,180		143		0.72		0.68		0.66		0.46		<0.68		10.9	
3a	2	1.0"	322,000	79	3,320	64	113	79	0.81	113	0.14	21	0.48	73	0.39	85	<0.54	--	18.8	173
3d	2	1.0"	47,300	12	345	7	69	48	0.095	13	0.047	6.9	0.06	9	0.05	11	<0.08	--	5.5	51
3e	2	1.0"	22,600	5	6.4	0.1	10	7	0.16	22	0.0028	0.4	0.012	2	0.005	1.1	<0.04	--	0.34	3.
3	3	0.15"	44,100		235		63		0.085		0.012		0.040		0.026		0.051		2.8	
3c	3	0.15"	4,970	11	260	110	62	98	0.015	18	--	--	--	--	--	--	--	--	--	--
3d	3	0.15"	5,620	13	64	27	52	83	0.0026	3.1	--	--	--	--	--	--	--	--	--	--
3e	3	0.15"	4,540	10	19	8.1	14	22	0.0052	6.1	--	--	--	--	--	--	--	--	--	--
4	3	0.15"	14,700		81		40		0.023		0.014		0.029		0.022		0.015		1.0	
4A	3	0.15"	3,380	23	23	28	13	33	0.0092	40	--	--	--	--	--	--	--	--	--	--

* % - Upstream site as percent of total outfall discharge for each parameter.

Outfall Bioassays

Both acute and subacute (chronic) toxicity was very pronounced in the outfall samples. A summary of the runoff toxicity test results is listed in Table 7.

Perhaps the most dramatic results occurred with the salmonid test. Trout sustained 100 percent mortality on the three outfalls tested, at a 65 percent runoff concentration. Moreover, death was complete within the first 24 hours of the 96-hour test.

Considerable chronic toxicity was indicated by Ceriodaphnia. The no--observed-effects concentration (NOEC) of the runoff was 3, 10, and 10 percent, respectively, for outfalls numbers 1, 2, and 3. Runoff concentrations greater than the NOEC caused a statistically significant ($P < 0.05$) decrease in reproduction compared to the control. The chronic effects were generally seen at lower concentrations than adult deaths (acute effects). Outfall #1 was somewhat more toxic than outfalls #2 and 3, and had the highest concentration of PCP and PNA's.

Selenastrum algal growth was inhibited, for the most part, by PWT runoff. As compared to the control, growth was inhibited from 94.5 to 98.7 percent, plus a 13.6 percent stimulation response by the filtered outfall #3 sample. However, several interferences were noted by the lab. Adverse effects due to high particulate concentrations and the presence of potential algal predators, such as protozoans, were predicted. Also, the surviving algae tended to "clump" together for unknown reasons, making enumeration difficult (R. Rousseau, E.V.S., phone conversation). Since the effects of these factors cannot be quantified, the Selenastrum results are not very useful.

The very high runoff toxicity may have been caused by several constituents, perhaps in combination. Ambient water quality criteria for PCP is 11 to 17 ug/L (EPA 1986) and a 96-hour LC50 for rainbow trout of 48-56 ug/L (Johnson & Finley, 1980). This compares to outfalls #1, 2, and 3 concentrations of 107, 22, and 68 ug/L, respectively. Chlorinated dioxins were not analyzed but are generally present in PCP at low concentrations as a contaminant (T. Watson, EPA Region 10, personal communication). Also, total PNA's were 253, 23, and 83 ug/L in outfalls #1, 2, and 3, respectively. No numerical criteria for total PNA's exist at this time due to a limited data base. However, acute toxicity to saltwater species is known to occur at 300 ug/L or less (EPA 1986).

Runoff metals results are listed in Tables 3 and 8. The contribution of metals to the overall toxicity is not clear. Total metals concentrations were generally high. However, EPA recommends the "total recoverable" metals analysis be used to compare against the water quality criteria. The total metals method is a more rigorous digestion and should give higher results than the total recoverable method. It is therefore difficult to compare these results against the criteria. Analysis of total dissolved metals would be expected to give lesser concentrations than with the total recoverable method. Dissolved metals, in addition to total metals, were run on outfall #4 during Phase 3 (Table 8). Dissolved copper exceeded both acute and chronic criteria (22 ug/L versus 18 and 12). This indicates that metals were possible contributors to the observed toxicity. In future analyses, the total recoverable method should be used.

Table 7. Stormwater Bioassay Results-Pacific Woodtreating Corporation Class II Inspection: 1986-1987.

Organism	Outfall #1	Outfall #2	Outfall #3
Trout			
% Survival @ 65% Runoff	-0-	-0-	-0-
Ceriodaphnia			
NOEC*, % Runoff	3	10	10
Selenastrum			
% Inhibition @ 100% Runoff:			
Filtered	98.9	94.5	13.6% Stimulation
Unfiltered	98.7	94.5	96.6

* No observed effect concentration: "Highest concentration . . . which causes no statistcally significant adverse effect on the observed parameters". (EPA, 1985).

Table 8. Metals results(*) and EPA water quality criteria-Pacific Woodtreating Corporation Class II Inspection: 1986-1987.

Analysis by:	Ecology(a)			PWT (b)			PWT (b)			Ecology (a)		PWT (c)				EPA Criteria:+	
Date:	10/30/86			10/30/86			3/3/87			11/24/87		11/24/87					
Outfall #	#1	#2	#3	#1	#2	#3	#1	#2	#3	#4	#4 dissolved	#1	#2	#3	#4	Acute	Chronic
Cadmium	1.6	1.6	0.5	-	-	-	-	-	-	-	-	-	-	-	-	3.92	1.13
Chromium	134	235	74	157	206	81	112	155	136	177	5	260	510	70	150	1737	207
Copper	421	312	127	417	199	184	164	694	193	237	22	560	480	110	180	18	12
Lead	<5	7	9	-	-	-	-	-	-	-	-	-	-	-	-	82	3
Mercury	0.09	0.045	0.09	-	-	-	-	-	-	-	-	-	-	-	-	2.4	0.012
Zinc	240	744	274	464	766	462	-	-	-	-	-	-	-	-	-	321	47

* - All results are in ug/L, and are 'total metals' unless otherwise indicated.
a - Ecology's Manchester Laboratory
b - Coffee Laboratories, Inc., Portland, OR.
c - Columbia Analytical Services, Inc., Longview, WA.
\+ - Hardness of 100 mg/L is assumed

Total Aromatics Procedure

A procedure to measure the "total aromatic" content of water samples at PWT was tried during Phase 3 sampling. The objective was to find a relatively simple, low-cost lab procedure that might replace more expensive organic analysis while providing a good estimate of the PNA content of the runoff streams. Sample preparation called for extracting and con-centrating the sample in the same manner as for BNA's. Spectrophotometric absorption was then measured at 254 nanometers, and concentrations were determined from a standard curve prepared from known spiking solutions. These values were compared with BNA aromatic results from the same samples.

Results are listed in Table 9. Total aromatic and BNA aromatic results did not correlate well, either between samples or between labs. Several factors could have been involved. A wide range of interfering compounds can absorb at 254 nanometers (Huntamer, 1988). Also, changes in runoff background conditions and constituents, and relative concentrations of various PNA compounds, could adversely affect reliability (Huntamer, 1988; C. Elliott, Columbia Analytical Services, personal communication). Therefore, use of the total aromatics procedure is not recommended.

Sediment Quality

Two types of sediments were analyzed: river sediments, and on-site catch basins. Organic analyses and general chemistry for these samples are listed in Appendices II and III. Organics are summarized in Table 10, and metals in Table 11.

Several volatile organics were detected in the catch basin samples. Benzene, ethylbenzene, toluene, and xylenes are creosote components, and also are indicators of gasoline. Tri- and tetrachloroethene are cleaning solvents and may be associated with the auto shop and vehicle cleaning area upstream from basin #3. Methylene chloride is a laboratory cleaning solvent and common contaminant of laboratory glassware.

In the river samples, no organic contaminants were found in detectable concentrations at the upstream control site, below outfall #1 (sample #1), or the downstream site (sample #3). Several PNA's were found in river sample #2, collected immediately below outfall #3. Based on percent fines in the samples (Appendix III), sample sites #2 and 3 were not highly depositional areas. Therefore, sediment contamination in Lake River may be masked by downstream transport of the fine-grained river sediments.

The sediment from the two catch basins were quite high in PNA's. This group of chemicals comprise 90 percent of creosote and are of particular interest because of their carcinogenic behavior (Merrill & Wade, 1985).

The sediment from the catch basins may qualify for designation as dangerous waste (DW). When sampled, both catch basin sediments qualified as DW by having greater than 0.01 percent (100 ppm) of total halogenated hydrocarbons (Washington Administrative Code 173-303-102, persistent dangerous waste definitions). Total PNA's were below the DW level

Table 9. Total aromatics vs. BNA aromatics results-Pacific Woodtreating Corporation Class II Inspection: 1986-1987 (mg/L).

	BNA Aromatics*		Total Aromatics	
Sampe #	Ecology	PWT	Ecology	PWT
Blank	0.0	--	4.5	--
1	--	2.5	30	2.0
2	--	0.052	6.6	0.67
3	--	0.032	2.5	0.33
4	0.11	0.078	13	1.3
2B	--	--	--	0.87
3C	--	--	--	0.52
3D	--	--	--	0.61
3E	--	--	--	0.87
4A	--	--	--	6.6

Table 10. Compounds Detected in Sediment Samples-Pacific Woodtreating Corporation Class II Inspection: 1986-87.

Parameter (ug/kg dw)	Control	Sed. #1	Sed. #2	Sed. #3	Catch Basin #1	Catch Basin #3
Methylene Chloride	**6.0B**	**17.9B**	**2.8B**	**1.7JB**	17u	17u
Trichloroethene	0.8u	1.0u	0.9u	0.9u	7u	**20**
Benzene	1.0u	1.3u	1.1u	1.1u	9u	**10**
Tetrachloroethene	0.7u	0.9u	0.8u	0.8u	6u	**14**
Toluene	0.9u	1.1u	1.0u	1.0u	**15**	**265**
Ethylbenzene	1.3u	1.6u	1.4u	1.4u	**13**	**1010**
Total Xylenes	1.4u	1.8u	1.6u	1.6u	**91**	**3190**
bis(2-Chloroethyl)Ether	448u	539u	421u	387u	**1330J**	2850u
4-Methylphenol	327u	393u	307u	282u	3890u	**3200**
Naphthalene	280u	337u	263u	242u	**3780**	**59900**
2-Methylnaphthalene	485u	584u	457u	419u	**17200**	**39100**
2-Chloronaphthalene	168u	202u	158u	145u	**1670J**	1070u
Acenaphthylene	75u	90u	70u	65u	**4670**	470u
Acenaphthene	700u	843u	658u	605u	**55300**	**40500**
Dibenzofuran	327u	393u	307u	282u	**37000**	**25600**
Fluorene	271u	326u	255u	234u	**61000**	**34900**
Pentachlorophenol	103u	124u	97u	89u	**18700**	650u
Phenanthrene	401u	483u	**270J**	347u	**151300**	**60500**
Anthracene	317u	382u	**79J**	274u	**62300**	**19000**
Fluoranthene	149u	180u	**690**	129u	**211300**	**69400**
Pyrene	196u	236u	**680**	169u	**135700**	**62300**
Benzo(a)Anthracene	47u	56u	**140**	40u	**55500**	**20800**
bis(2-Ethylhexyl)Phthalate	327u	393u	307u	282u	**1220J**	**9400**
Chrysene	84u	101u	**280**	73u	**84500**	**25700**
Benzo(b)Fluoranthene	364u	438u	342u	315u	**40000**	**18800**
Benzo(k)Fluoranthene	308u	371u	290u	266u	**27400**	**9020**
Benzo(a)Pyrene	103u	124u	**61M**	89u	**17700**	**7120**
Indeno(1,2,3-cd)Pyrene	196u	236u	184u	169u	**8100**	**5160**
Dibenz(a,h)Anthracene	177u	213u	176u	153u	**3800**	**2080**
Benzo(ghi)Perylene	317u	382u	299u	274u	**6800**	**4510**

Qualifiers:

u = Compound was analyzed for but not detected at the given detection limit.

J = Estimated value when result is less than the specified detection limit.

B = Analyte was found in blank as well as a sample, and indicates possible/probable blank contamination.

M = Estimated value of analyte found and confirmed by analyst, but with low spectral match parameters.

Table 11. Sediment metals results-Pacific Woodtreating Corporation Class II inspection, 1986-1987 (mg/kg).

Metal	Criteria*	Sediment # 1	Sediment # 2	Sediment # 3	Upstream Control	Catch Basins # 1	Catch Basins # 30
Antimony	---	<0.1	<0.1	<0.1	<0.1	<0.1	0.4
Arsenic	10	4.2	7.2	3.1	**12.3**	**65.1**	**71.4**
Beryllium	---	0.48	0.25	0.23	0.39	0.42	0.29
Cadmium	1.0	**1.0**	0.54	**1.16**	0.49	0.44	**2.09**
Chromium+3	100	15.2	26.8	12.3	12.4	95.9	**157**
Copper	100	25.8	20.1	14.5	9.8	**112.3**	**289.5**
Lead	50	7.6	5.7	6.0	7.2	18.9	**93.1**
Mercury	0.10	0.029	0.03	0.021	0.016	0.021	**0.117**
Nickel	100	15.3	13.1	14.6	12.8	28.9	13.7
Selenium	---	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silver	---	0.02	0.04	0.04	<0.02	0.03	0.03
Thallium	---	0.2	0.1	0.1	0.1	0.2	0.1
Zinc	100	97.5	133	88.6	72.2	113	972

*Interim criteria for open-water disposal of dredged materials - Wisconsin Department of Natural Resources, 1985.

of greater than 1 percent (0.02 and 0.006 percent for basins #1 and 3, respectively). In addition, basin #1 contained 18.7 ppm (dry weight) of pentachlorophenol. Other DW criteria such as EP TOX metals and fish toxicity were not checked.

Significant metals contamination of Lake River sediments was not observed, as compared to freshwater sediment criteria and the upstream sample (Table 11). However, concentrations of several metals from the catch basin samples were quite elevated. Further testing such as the EP TOX test should therefore be conducted prior to disposal of these materials.

Sediment Bioassay Results

Results of the Daphnia magna sediment bioassays are listed in Table 12. Very good survival occurred in the laboratory reference sediment and water controls; the field control sample; and river sediment samples #1 (near outfall #1) and #3 (downstream). However, mortality was 100 percent in both sediment catch basin samples and twenty-five percent in sediment sample #2. Mortalities seemed to be linked to sediment PNA concentrations, as shown in Table 12.

A 1984 study of crayfish and sediment in Lake River found no conclusive evidence of significant contamination to the sediment sample or bioaccumulation in crayfish tissue near PWT (Neel and Bailey, 1984).

Best Management Practice Recommendations

EPA, with input from Oregon's Department of Environmental Quality, has drafted a set of suggested Best Management Practices (BMPs) for the wood-treating industry (D. Tangerone, EPA Region 10, personal communication). Several of these suggestions are now discussed.

EPA recommends the reuse of stormwater runoff when possible (process make-up water, evaporation, etc.), thereby eliminating the discharge of toxic materials. Because of their toxic nature, the more contaminated streams at PWT are recommended for reuse or on-site evaporation. These include outfall #1 and the concrete pond effluent (site #3a). A larger evaporator system might be needed to handle the increased volume.

Treatment of any contaminated stormwater runoff is suggested by EPA. Treatment methods at PWT could include low-velocity settling basins for suspended solids removal and absorbent booms for oil and grease removal, for all outfalls. Exceptions would be any outfall whose discharge is reused or evaporated on-site. An option would be to install sediment and oil removal basins for all outfalls if sufficient contaminant removal can be shown by this process alone. Runoff reuse or evaporation would then not be necessary.

EPA suggests that biomonitoring be conducted for discharges to receiving streams and that environmental monitoring be conducted on stormwater runoff. Therefore, periodic biomonitoring along with chemical analyses is recommended to monitor the toxicity and strength of stormwater runoff, and to note positive changes due to improved practices. Specifically, rainbow trout and Ceriodaphnia or Daphnia magna could be used for the

Table 12. *Daphnia magna* sediment bioassay results-Pacific Woodtreating Corporation Class II Inspection: 1986-1987.

Sample Site	% Survival*	Total PNA Concentration mg/kg D.W.
Sediment #1	97.5	U
Sediment #2	75	2.2
Sediment #3	100	U
Field Sediment Control	97.5	U
Drain #1	0	930
Drain #3a	0	440
Lab Sediment Control	100	--
Lab Water Control	100	--

* = Percent survival out of 40: 20 organisms per replicate times 2 replicates.
U = None detected

bioassays. Chemical analyses should include PCP and a BNA scan, or several individual BNA components. These tests should be conducted on all discharges simultaneously to chart temporal relationships of the outfalls.

For pressure treaters such as PWT, EPA recommends that drip pad and transfer table areas be paved and impermeable. The drip pad area at PWT is paved but may no longer be impermeable due to weathering, settling, etc. This should be checked and corrected if necessary. Also, covering of sensitive areas such as the drip pad area could eliminate runoff contamination from these areas.

CONCLUSIONS

The stormwater runoff study revealed pentachlorophenol (PCP) and polynuclear aromatic hydrocarbons (PNA) are present in PWT surface runoff, on-site sediment catch basins, and some near-field sediments. Runoff concentrations of PCP may be the main cause of the high toxicity measured by three bioassays, although PNA's and metals may have contributed. The on-site catch basin sediments were highly contaminated with PNA's while the sediment sample from Lake River at Outfall #3 contained more modest amounts. Sediment bioassay toxicity appeared to be closely linked to sediment PNA concentrations. Catch basin sediments exceeded Washington's total halogenated hydrocarbon designation level for dangerous waste.

RECOMMENDATIONS

The most contaminated streams, outfall #1 and site 3a, are recommended for reuse or on-site evaporation.

Suspended solids settling basins with oil removal are recommended for all outfalls. If proven highly effective, this method could replace reuse of streams #1 and 3a.

"Clean" roof runoff should be separated from contaminated streams prior to treatment to increase efficiency and decrease treatment costs.

Periodic chemical and biomonitoring testing is recommended for all final discharges. The total recoverable method should be used for metals analysis. These data will confirm toxicity relationships at PWT and serve as an indicator of effectiveness of runoff contaminant reduction measures.

Further characterization of sites numbers 3a, c, d, and e are needed to fully understand the sources of high contamination in system #3.

Treated lumber must remain on the drip pads until fully cooled to prevent unnecessary carry-over of preservatives to the wood storage area.

The asphalt drip pad and transfer table areas should be checked to make sure that they are impermeable. These areas could also be covered to eliminate rainfall runoff.

Sediment should be immediately removed from existing catch basins and both #3 concrete junction boxes to improve capture efficiency. In addition to organics, the EP TOX metals analysis should be run for possible DW designation.

Chemical characterization of the boiler blowdown water is suggested.

EPA-approved CLP lab procedures are recommended for sample analyses by PWT.

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APPENDICES

Appendix I. BNA and VOA Runoff Results-Pacific Woodtreating Corporation Class II Inspection: 1986-1987.

Parameter (µg/L)	#1	#2	#3	#1A	#2A	#3A	#3b
Date - 10/30/86							
Chloromethane	10u	10u	10u	10u	10u	10u	
Bromomethane	10u	10u	10u	10u	10u	10u	
Vinyl Chloride	10u	10u	10u	10u	10u	10u	
Chloroethane	10u	10u	10u	10u	10u	10u	
Methylene Chloride	5u	5u	5u	5u	5u	5u	
Acetone	10u	10u	10u	10u	10u	10u	
Carbon Disulfide	5u	5u	5u	5u	5u	5u	
1,1-Dichloroethene	5u	5u	5u	5u	5u	5u	
1,1-Dichloroethane	5u	5u	5u	5u	5u	5u	
Trans-1,2-Dichloroethene	5u	5u	5u	5u	5u	5u	
Chloroform	5u	5u	5u	5u	5u	5u	
1,2-Dichloroethane	5u	5u	5u	5u	5u	5u	
2-Butanone	10u	10u	10u	10u	10u	10u	
1,1,1-Trichloroethane	5u	5u	5u	5u	5u	5u	
Carbon Tetrachloride	5u	5u	5u	5u	5u	5u	
Vinyl Acetate	10u	10u	10u	10u	10u	10u	
Bromodichloromethane	5u	5u	5u	5u	5u	5u	
1,2-Dichloropropane	5u	5u	5u	5u	5u	5u	
Trans-1,3-Dichloropropene	5u	5u	5u	5u	5u	5u	
Trichloroethene	5u	5u	**1T**	5u	5u	**1T**	
Dibromochloromethane	5u	5u	5u	5u	5u	5u	
1,1,2-Trichloroethane	5u	5u	5u	5u	5u	5u	
Benzene	5u	5u	5u	5u	5u	5u	
cis-1,3-Dichloropropene	5u	5u	5u	5u	5u	5u	
2-Chloroethylvinylether	10u	10u	10u	10u	10u	10u	
Bromoform	5u	5u	5u	5u	5u	5u	
4-Methyl-2-Pentanone	10u	10u	10u	10u	10u	10u	
2-Hexanone	10u	10u	10u	10u	10u	10u	
Tetrachloroethene	5u	5u	5u	5u	5u	5u	
1,1,2,2-Tetrachloroethane	5u	5u	5u	5u	5u	5u	
Toluene	5u	5u	5u	5u	5u	**3J**	
Chlorobenzene	5u	5u	5u	5u	5u	5u	
Ethylbenzene	5u	5u	5u	5u	5u	5u	
Styrene	5u	5u	5u	5u	5u	5u	
Total Xylenes	5u	5u	5u	5u	5u	5u	
Phenol	4.3u	4.3u	4.3u	4.3u	4.3u	4.3u	4.3u
bis(2-Chloroethyl)Ether	4.8u	4.8u	4.8u	4.8u	4.8u	4.8u	4.8u
2-Chlorophenol	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u
1,3-Dichlorobenzene	2.9u	2.9u	2.9u	2.9u	2.9u	2.9u	2.9u
1,4-Dichlorobenzene	3.4u	3.4u	3.4u	3.4u	3.4u	3.4u	3.4u
Benzyl Alcohol	4.0u	4.0u	4.0u	**11**	4.0u	4.0u	4.0u
1,2-Dichlorobenzene	3.8u	3.8u	3.8u	3.8u	3.8u	3.8u	3.8u
2-Methylphenol	2.2u	3.5u	2.2u	**7.5**	3.5u	3.5u	3.5u
bis(2-chloroisopropyl)ether	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u	2.5u
4-Methylphenol	3.5u	3.5u	3.5u	**4.7**	3.5u	3.5u	3.5u
N-Nitroso-Di-n-Propylamine	4.8u	4.8u	4.8u	4.8u	4.8u	4.8u	4.8u
Hexachloroethane	5.2u	5.2u	5.2u	5.2u	5.2u	5.2u	5.2u
Nitrobenzene	3.8u	3.8u	3.8u	3.8u	3.8u	3.8u	3.8u
Isophorone	2.4u	2.4u	2.4u	2.4u	2.4u	2.4u	2.4u
2-Nitrophenol	3.2u	3.2u	3.2u	3.2u	3.2u	3.2u	3.2u
2,4-Dimethylphenol	4.6u	4.6u	4.6u	4.6u	4.6u	4.6u	4.6u
Benzoic Acid	3.3u	3.3u	3.3u	3.3u	3.3u	3.3u	3.3u
bis(2-Chloroethoxy)Methane	3.6u	3.6u	3.6u	3.6u	3.6u	3.6u	3.6u
2,4-Dichlorophenol	1.8u	1.8u	1.8u	**2.4**	1.8u	1.8u	1.8u

Appendix I. (continued)

Parameter (µg/L)	#1	#2	#3	#1A	#2A	#3A	#3b
Date - 10/30/86							
1,2,4-Trichlorobenzene	4.2u	4.2u	4.2u	4.2u	4.2u	4.2u	4.2u
Naphthalene	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u
4-Chloroaniline	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u
Hexachlorobutadiene	4.3u	4.3u	4.3u	4.3u	4.3u	4.3u	4.3u
4-Chloro-3-Methylphenol	1.4u	1.4u	1.4u	1.4u	1.4u	1.4u	1.4u
2-Methylnaphthalene	5.2u	5.2u	5.2u	**1.5J**	5.2u	5.2u	5.2u
Hexachlorocyclopentadiene	5.3u	5.3u	5.3u	5.3u	5.3u	5.3u	5.3u
2,4,6-Trichlorophenol	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
2,4,5-Trichlorophenol	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u	3.0u
2-Chloronaphthalene	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u	1.8u
2-Nitroaniline	1.2u	1.2u	1.2u	1.2u	1.2u	1.2u	1.2u
Dimethyl Phthalate	3.1u	3.1u	3.1u	3.1u	3.1u	3.1u	3.1u
Acenaphthylene	0.8u	0.8u	0.8u	0.8u	0.8u	0.8u	0.8u
3-Nitroaniline	6.6u	6.6u	6.6u	6.6u	6.6u	6.6u	6.6u
Acenaphthene	**4.7J**	**0.6J**	**1.7J**	7.5u	**1.4J**	**1.8J**	**3.8J**
2,4-Dinitrophenol	3.3u	3.3u	3.3u	3.3u	3.3u	3.3u	3.3u
4-Nitrophenol	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
Dibenzofuran	**2.1J**	**0.3J**	3.5u	**5.8**	3.5u	3.5u	**0.4J**
2,4-Dinitrotoluene	2.2u	2.2u	2.2u	2.2u	2.2u	2.2u	2.2u
2,6-Dinitrotoluene	2.6u	2.6u	2.6u	2.6u	2.6u	2.6u	2.6u
Diethylphthalate	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u	1.5u
4-Chlorophenyl-phenylether	6.3u	6.3u	6.3u	6.3u	6.3u	6.3u	6.3u
Fluorene	2.9u	2.9u	2.9u	**8.9**	2.9u	2.9u	2.9u
4-Nitroaniline	7.2u	7.2u	7.2u	7.2u	7.2u	7.2u	7.2u
4,6-Dinitro-2-Methylphenol	1.1u	1.1u	1.1u	1.1u	1.1u	1.1u	1.1u
N-Nitrosodiphenylamine	3.2u	3.2u	3.2u	3.2u	3.2u	3.2u	3.2u
4-Bromophenyl-phenylether	3.2u	3.2u	3.2u	3.2u	3.2u	3.2u	3.2u
Hexachlorobenzene	4.4u	4.4u	4.4u	4.4u	4.4u	4.4u	4.4u
Pentachlorophenol	**107**	**22**	**68**	**167**	**63**	**75**	**128**
Phenanthrene	**2.9J**	**0.2J**	**0.7J**	**18**	**0.8J**	**0.7J**	**1.0J**
Anthracene	**6.3**	**0.6J**	**1.1J**	**12**	**1.9J**	**1.0J**	**2.3J**
Di-n-Butylphthalate	4.1u	4.1u	4.1u	4.1u	**1.7J**	4.1u	4.1u
Fluoranthene	**81**	**9.5**	**22**	**138**	**24**	**24**	**34**
Pyrene	**76**	**6.5**	**29**	**122**	**16**	**29**	**20**
Butylbenxylphthalate	4.3u	4.3u	4.3u	4.3u	4.3u	4.3u	4.3u
3,3'-Dichlorobenzidine	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u	2.0u
Benzo(a)Anthracene	**14**	**1.3**	**6.0**	**23**	**3.5**	**5.5**	**4.7**
bis(2-Ethylhexyl)Phthalate	3.5u	**1.3J**	3.5u	3.5u	**3.3J**	**1.1J**	3.5u
Chrysene	**24**	**3.3**	**10**	**44**	**9.9**	**11**	**12**
Di-n-Octyl Phthalate	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
Benzo(b)Fluoranthene	**23**	**1.6J**	**4.8**	**22**	**4.7**	**4.7**	**4.6**
Benzo(k)Fluoranthene	**14**	**1.4J**	**6.0**	**28**	**4.9**	**5.1**	**5.4**
Benzo(a)Pyrene	**4.4**	**0.4J**	2.3	**8.4**	**1.4**	**1.8**	**1.8**
Indeno(1,2,3-cd)Pyrene	**1.5J**	2.1u	**0.7J**	**2.9**	**0.8J**	**0.4J**	**0.8J**
Dibenz(a,h)Anthracene	1.9u	1.9u	1.9u	1.9u	1.9u	1.9u	1.9u
Benzo(ghi)Perylene	**1.4J**	3.4u	**0.6J**	**2.6J**	**0.7J**	3.4u	**0.8J**

Qualifiers:
u = Compound was analyzed for but not detected at the given detection limit.
J = Estimated value when result is less than the specified detection limit.
B = Analyte was found in blank as well as a sample, and indicates possible/probable blank contamination.
M = Estimated value of analyte found and confirmed by analyst, but with low spectral match parameters.
T = applies to a "hit" that is not acceptable by EPA protocol but is considered 'real' by the analyst.

Appendix II. Sediment Organic Analyses-Pacific Woodtreating Corporation
Class II Inspection: 1986-1987.

Parameter (ug/kg dw)	Control	Sed. #1	Sed. #2	Sed. #3	Drain #1	Drain #3
Chloromethane	1.9u	2.4u	2.2u	2.1u	17u	17u
Bromomethane	2.5u	3.1u	2.8u	2.8u	22u	22u
Vinyl Chloride	2.2u	2.8u	2.5u	2.5u	19u	19u
Chloroethane	2.6u	3.3u	3.0u	2.9u	23u	23u
Methylene Chloride	**6.0B**	**17.9B**	**2.8B**	**1.7JB**	17u	17u
Acetone	6.9u	8.7u	7.8u	7.8u	61u	60u
Carbon Disulfide	1.2u	1.5u	1.3u	1.3u	11u	10u
1,1-Dichloroethene	2.7u	3.4u	3.0u	3.0u	24u	23u
1,1-Dichloroethane	1.2u	1.5u	1.3u	1.3u	11u	10u
Trans-1,2-Dichloroethene	1.6u	2.0u	1.8u	1.8u	14u	14u
Chloroform	1.5u	1.9u	1.7u	1.7u	13u	13u
1,2-Dichloroethane	1.4u	1.7u	1.5u	1.5u	12u	12u
2-Butanone	3.8u	4.7u	4.2u	4.2u	33u	33u
1,1,1-Trichloroethane	1.0u	1.2u	1.1u	1.1u	8u	8u
Carbon Tetrachloride	1.0u	1.3u	1.1u	1.1u	9u	9u
Vinyl Acetate	3.5u	4.3u	3.9u	3.9u	31u	30u
Bromodichloromethane	0.8u	1.0u	0.9u	0.9u	7u	7u
1,2-Dichloropropane	1.0u	1.2u	1.1u	1.1u	8u	8u
Trans-1,3-Dichloropropene	1.0u	1.3u	1.1u	1.1u	9u	9u
Trichloroethene	0.8u	1.0u	0.9u	0.9u	7u	**20**
Dibromochloromethane	1.0u	1.2u	1.1u	1.1u	8u	8u
1,1,2-Trichloroethane	1.0u	1.2u	1.1u	1.1u	8u	8u
Benzene	1.0u	1.3u	1.1u	1.1u	9u	**10**
cis-1,3-Dichloropropene	1.0u	1.3u	1.1u	1.1u	9u	9u
2-Chloroethylvinylether	1.5u	1.9u	1.7u	1.7u	14u	14u
Bromoform	1.1u	1.4u	1.3u	1.3u	10u	10u
4-Methyl-2-Pentanone	2.1u	2.7u	2.4u	2.4u	19u	19u
2-Hexanone	1.1u	1.4u	1.3u	1.3u	10u	10u
Tetrachloroethene	0.7u	0.9u	0.8u	0.8u	6u	**14**
1,1,2,2-Tetrachloroethane	1.3u	1.6u	1.4u	1.4u	11u	11u
Toluene	0.9u	1.1u	1.0u	1.0u	**15**	**265**
Chlorobenzene	0.8u	1.0u	0.9u	0.9u	7u	7u
Ethylbenzene	1.3u	1.6u	1.4u	1.4u	**13**	**1010**
Styrene	1.6u	2.0u	1.8u	1.8u	14u	14u
Total Xylenes	1.4u	1.8u	1.6u	1.6u	**91**	**3190**
Phenol	401u	483u	378u	347u	4780u	2550u
bis(2-Chloroethyl)Ether	448u	539u	421u	387u	**1330J**	2850u
2-Chlorophenol	233u	281u	219u	202u	2780u	1480u
1,3-Dichlorobenzene	271u	326u	255u	234u	3230u	1720u
1,4-Dichlorobenzene	317u	382u	299u	274u	3780u	2020u
Benzyl Alcohol	373u	449u	351u	323u	4450u	2370u
1,2-Dichlorobenzene	355u	427u	334u	306u	4230u	2250u
2-Methylphenol	205u	247u	193u	177u	2450u	1300u
bis(2-chloroisopropyl)ether	233u	281u	219u	202u	2780u	1480u
4-Methylphenol	327u	393u	307u	282u	3890u	**3200**
N-Nitroso-Di-n-Propylamine	448u	539u	421u	387u	5340u	2850u
Hexachloroethane	485u	584u	457u	419u	5780u	3080u
Nitrobenzene	355u	427u	334u	306u	4230u	2250u
Isophorone	224u	270u	211u	194u	2670u	1420u
2-Nitrophenol	299u	360u	281u	258u	3560u	1900u
2,4-Dimethylphenol	429u	517u	404u	371u	5120u	2730u
Benzoic Acid	308u	371u	290u	266u	3670u	1960u
bis(2-Chloroethoxy)Methane	336u	404u	316u	290u	4000u	2140u
2,4-Dichlorophenol	168u	202u	158u	145u	2000u	1070u

Appendix II. (continued)

Parameter (ug/kg dw)	Control	Sed. #1	Sed. #2	Sed. #3	Drain #1	Drain #3
1,2,4-Trichlorobenzene	392u	472u	369u	339u	4670u	2490u
Naphthalene	280u	337u	263u	242u	**3780**	**59900**
4-Chloroaniline	168u	202u	158u	145u	2000u	1070u
Hexachlorobutadiene	401u	483u	378u	347u	4780u	2550u
4-Chloro-3-Methylphenol	131u	157u	123u	113u	1560u	830u
2-Methylnaphthalene	485u	584u	457u	419u	**17200**	**39100**
Hexachlorocyclopentadiene	495u	596u	465u	427u	5900u	3140u
2,4,6-Trichlorophenol	187u	225u	176u	161u	2220u	1190u
2,4,5-Trichlorophenol	280u	337u	263u	242u	3340u	1780u
2-Chloronaphthalene	168u	202u	158u	145u	**1670J**	1070u
2-Nitroaniline	112u	135u	105u	97u	1330u	710u
Dimethyl Phthalate	289u	348u	272u	250u	3450u	1840u
Acenaphthylene	75u	90u	70u	65u	**4670**	470u
3-Nitroaniline	616u	742u	579u	532u	7340u	3910u
Acenaphthene	700u	843u	658u	605u	**55300**	**40500**
2,4-Dinitrophenol	308u	371u	290u	266u	3670u	1960u
4-Nitrophenol	187u	225u	176u	161u	2220u	1190u
Dibenzofuran	327u	393u	307u	282u	**37000**	**25600**
2,4-Dinitrotoluene	205u	247u	193u	177u	2450u	1300u
2,6-Dinitrotoluene	243u	292u	228u	210u	2890u	1540u
Diethylphthalate	140u	169u	132u	121u	1670u	890u
4-Chlorophenyl-phenylether	588u	708u	553u	508u	7010u	3740u
Fluorene	271u	326u	255u	234u	**61000**	**34900**
4-Nitroaniline	672u	809u	632u	581u	8010u	4270u
4,6-Dinitro-2-Methylphenol	103u	124u	97u	89u	1220u	650u
N-Nitrosodiphenylamine	299u	360u	281u	258u	3560u	1900u
4-Bromophenyl-phenylether	299u	360u	281u	258u	3560u	1900u
Hexachlorobenzene	411u	494u	386u	355u	4890u	2610u
Pentachlorophenol	103u	124u	97u	89u	**18700**	650u
Phenanthrene	401u	483u	**270J**	347u	**151300**	**60500**
Anthracene	317u	382u	**79J**	274u	**62300**	**19000**
Di-n-Butylphthalate	383u	461u	360u	331u	4560u	2430u
Fluoranthene	149u	180u	**690**	129u	**211300**	**69400**
Pyrene	196u	236u	**680**	169u	**135700**	**62300**
Butylbenxylphthalate	401u	483u	378u	347u	4780u	2550u
3,3'-Dichlorobenzidine	187u	225u	176u	161u	2220u	1190u
Benzo(a)Anthracene	47u	56u	**140**	40u	**55500**	**20800**
bis(2-Ethylhexyl)Phthalate	327u	393u	307u	282u	**1220J**	**9400**
Chrysene	84u	101u	**280**	73u	**84500**	**25700**
Di-n-Octyl Phthalate	93u	112u	88u	81u	1110u	590
Benzo(b)Fluoranthene	364u	438u	342u	315u	**40000**	**18800**
Benzo(k)Fluoranthene	308u	371u	290u	266u	**27400**	**9020**
Benzo(a)Pyrene	103u	124u	**61M**	89u	**17700**	**7120**
Indeno(1,2,3-cd)Pyrene	196u	236u	184u	169u	**8100**	**5160**
Dibenz(a,h)Anthracene	177u	213u	176u	153u	**3800**	**2080**
Benzo(ghi)Perylene	317u	382u	299u	274u	**6800**	**4510**

Qualifiers:
u = Compound was analyzed for but not detected at the given detection limit.
J = Estimated value when result is less than the specified detection limit.
B = Analyte was found in blank as well as a sample, and indicates possible/ probable blank contamination.
M = Estimated value of analyte found and confirmed by analyst, but with low spectral match parameters.

Appendix III. Sediment Sample Data-Pacific Woodtreating Corporation Class II Inspection: 1986-1987.

Sample	% Solids	TOC, % dry	Grain Size Analysis, %			
			Gravel >2 mm	Sand 2mm-62mm	Silt 62mm-4mm	Clay <4mm
Control	66.2	0.6	1.5	91	6.4	1.5
#1	53.8	0.4	0.02	27	66	4.7
#2	59.1	0.9	2.9	68	26	2.6
#3	55.9	0.2	1.2	81	17	2.5
Drain #1	57.7	4.6	0.11	9.7	77	11
Drain #3	45.6	8.1	0.40	16	69	12